

# **Comprehensive Assessment and Monitoring Program (CAMP)**

## **Annual Report 1998**

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# Comprehensive Assessment and Monitoring Program (CAMP)

## *Annual Report* 1998

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# Summary

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This annual report of the Comprehensive Assessment and Monitoring Program (CAMP) documents the 1998 monitoring results and presents summary data for the first four years of anadromous fish population monitoring under the requirements of the Central Valley Project Improvement Act (CVPIA). The adult anadromous fish monitoring showed variable results in making progress towards meeting CVPIA natural production goals. Returning adult fall-run chinook salmon were at their lowest levels in 1998 relative to all years (1995-1997) previously monitored under CAMP. However, within individual watersheds such as Battle, Butte and Mokelumne, adult salmon returns were at or above the watershed-specific production targets. In addition, estimates of natural production of spring-run and winter-run chinook salmon were at the highest levels of all CAMP-monitored years. American shad numbers increased in 1998 relative to 1997; however, abundance estimates for 1998 were unavailable for steelhead, striped bass, and sturgeon.

The 1998 report includes changes in the method for estimating fall-run salmon in the mainstem Sacramento River and revised natural production estimates for the years 1995 through 1997 for all chinook salmon races. These changes were made to maintain consistency with the current estimation method used by the California Department of Fish and Game (CDFG). This method, however, is subject to complications that may not accurately reflect adult chinook salmon numbers in the mainstem Sacramento River, Clear Creek, and Battle Creek. CDFG and CAMP representatives are working to refine the methods to better estimate adult salmon numbers in these waters.

The CAMP juvenile salmon monitoring program was continued in 1998 to provide a portion of the data that will be used to evaluate the relative effectiveness of the four categories of restoration actions. Few watersheds reported juvenile production data for 1998. Based on an index of juvenile production to spawning adults, juvenile production in all reporting watersheds improved in 1998 compared to the previous CAMP-monitored years.

While the CAMP juvenile program is intended to provide long-term watershed-specific monitoring of juvenile production, these data are not sufficient to distinguish the relative effectiveness of the four categories of actions to restore anadromous fish populations. Data resulting from site-specific monitoring of AFRP restoration actions are needed to provide the critical link between the types of restoration actions implemented within a watershed to overall juvenile production within that watershed. However, without site-specific monitoring data, CAMP's goal of assessing which types of restoration actions are most effective in restoring fish populations cannot be addressed. As outlined in the CAMP Implementation Plan (USFWS 1997b), the site-specific monitoring data must be developed by each individual project, not CAMP.

# Contents

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Section	Page
Summary .....	i
1. Introduction .....	1-1
Background.....	1-1
CAMP Methods .....	1-3
CAMP Implementation Goals.....	1-3
Implementation of CAMP through 1998.....	1-5
2. Adult Fish Monitoring Program: 1998 .....	2-1
AFRP Production Targets.....	2-1
Adult Abundance Estimates: 1998 .....	2-1
Chinook Salmon.....	2-1
Other Species.....	2-9
3. Juvenile Monitoring Program: 1998 .....	3-1
4. References .....	4-1

## Appendix

- A CAMP Juvenile Monitoring Program: Effects of Restoration Actions on Abundance of Juvenile Chinook Salmon at Emigration
- B CAMP Juvenile Monitoring Program: Summary of Juvenile Chinook Salmon Monitoring, 1995-1997 Detailed Methods and Results

## Tables

1	CAMP: Recommended Adult Fish Monitoring Programs .....	1-3
2	CAMP: Recommended Juvenile Salmon Monitoring Programs .....	1-5
3	1998 Adult Chinook Salmon Production Estimates.....	2-2
4	Chinook Salmon Production Calculations with Preliminary and Final Ocean Harvest Values .....	2-4
5	Fall-Run Chinook Salmon Baseline Production Estimates, Production Targets and estimates of Natural Production for 1995 Through 1998 .....	2-6
6	Fall-Run Chinook Salmon In-River Escapement Estimates.....	2-7

7	Fall-Run Chinook Salmon Hatchery Returns.....	2-7
8	Fall-Run Chinook Salmon In-River Harvest .....	2-8
9	Winter-Run Chinook Salmon Baseline Production Estimate, Production Target and Estimates of Natural Production for 1995 Through 1998 .....	2-8
10	Spring-Run Chinook Salmon Baseline Production Estimates, Production Targets and Estimates of Natural Production for 1995 Through 1998 .....	2-9
11	Steelhead, American Shad, Striped Bass, White Sturgeon, and Green Sturgeon Adult Spawner Estimates for 1995 Through 1998 .....	2-9
12	Summary of Restoration Actions Completed In Recent Years in the American, Feather, Mokelumne, and Stanislaus Rivers .....	3-2
13	Summary of Estimated Numbers of Juvenile Chinook Salmon Emigrating from the American, Feather, Mokelumne, and Stanislaus Rivers, 1998.....	3-2
14	Index of Emigrating YOY to the Abundance of Adult Spawners .....	3-2

## Figures

1	Fall-Run Chinook Estimates by Watershed for 1995-1998 .....	2-6
2	Comparison of In-river Run Size (escapement + in-river harvest - hatchery returns) for Natural Chinook Salmon in Four Major Drainages on the West Coast. ....	2-10

# 1. Introduction

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This second annual report of the Comprehensive Assessment and Monitoring Program (CAMP) has been prepared for the Central Valley Fish and Wildlife Restoration Program Office, U.S. Fish and Wildlife Service (USFWS) and the Bureau of Reclamation (Reclamation). The report summarizes estimates of anadromous fish abundance, associated environmental data, and fish and wildlife restoration actions implemented in the Central Valley, California for 1998, pursuant to the enactment of the Central Valley Project Improvement Act (CVPIA).

## Background

The CVPIA (Public Law 102-575, Title 34) of October 1992 amends the authority of Reclamation Central Valley Project (CVP) to include fish and wildlife protection, restoration, and mitigation as an equal priority with other CVP functions, which include navigation, flood control, irrigation, and municipal water supply. Section 3406 (b) of the CVPIA directs the Secretary of Interior through the USFWS to develop and implement programs and actions to ensure that by 2002 the natural production of anadromous fish in Central Valley streams will be sustainable, on a long-term basis, at levels at least twice the average levels of natural production during the 1967 through 1991 baseline period.

The Anadromous Fish Restoration Program (AFRP) was established by Section 3406 (b)(1) of the CVPIA. The AFRP established baseline production numbers for Central Valley streams for naturally produced chinook salmon (all races), steelhead, striped bass, American shad, white sturgeon, and green sturgeon. Baseline production estimates were developed using monitoring data collected from 1967 through 1991. Production targets for anadromous fish were determined by doubling the baseline production estimates.

The CAMP, established by Section 3406(b)(16) of the CVPIA, has two distinct goals:

- To assess the overall effectiveness of actions implemented pursuant to CVPIA Section 3406(b) in meeting the AFRP production targets.
- To assess the relative effectiveness of four categories of Section 3406(b) actions (i.e., water management modifications, structural modifications [excluding fish screens], habitat restoration, and fish screens) in meeting AFRP production targets.

This section of the 1998 CAMP Annual Report includes the results of monitoring performed to estimate the natural production of anadromous fish in each watershed for which an AFRP target has been established.

The recommended methods by which data are collected to evaluate progress toward these goals were originally outlined in the CAMP Conceptual Plan (USFWS 1996). The CAMP Implementation Plan (USFWS 1997) further refined recommendations for adult and juvenile production monitoring programs necessary to achieve CAMP's two primary goals and

## CAMP Methods

### CAMP Implementation Goals

The CAMP Implementation Plan describes the components of the recommended adult and juvenile monitoring programs. The recommended adult fish monitoring program for the CAMP species (including all races of chinook salmon) is summarized in Table 1. The recommended juvenile salmon monitoring program is shown in Table 2.

To successfully monitor progress toward meeting anadromous fish production targets (CAMP's first goal), reliable methods for distinguishing hatchery and naturally produced fish will be needed. The recommended constant fractional marking program for hatchery-produced chinook salmon in the Central Valley will provide a means for improving estimates of the contribution of hatchery fish to total adult chinook salmon production. As described in the previous annual report, a workshop to discuss a hatchery marking program was conducted with agency and stakeholder representatives on October 2, 1997. Subsequent study focused on the need to standardize the marking effort to meet CAMP's goals. A recommended uniform coded wire tag and fin-clipping program is expected in 1999, with implementation in 2000.

To evaluate the relative effectiveness of the various AFRP actions (CAMP's second goal), it is important to distinguish the effects of key environmental variables that may affect juvenile abundance independently of actions. Flow, temperature, and turbidity measurements have been compiled as part of the juvenile monitoring program for most of the streams shown in Table 2. Temperature and turbidity were collected incidental to trap operations. Flow data were obtained from other sources, including U.S. Geological Survey (USGS) and Department of Water Resources (DWR) flow monitoring gages. Also important in achieving CAMP's second goal is the implementation of a standardized, site-specific monitoring program to evaluate the effectiveness of individual restoration actions. The AFRP has begun planning this monitoring program. Program implementation will provide valuable information in the overall evaluation of the relative effectiveness of restoration actions analyzed as part of the CAMP juvenile monitoring program. CAMP is currently reviewing existing and planned fish screen facilities to select representative locations for conducting focused evaluations of the effectiveness of fish screens in meeting AFRP goals. A pilot program to evaluate fish screen effectiveness is expected to be initiated in 2000.

**TABLE 1**  
CAMP: Recommended Adult Fish Monitoring Programs

Watershed	Species/Race	Adult Fish Monitoring Programs
<b>Chinook Salmon</b>		
American River	Fall-run Chinook Salmon	Spawning escapement, hatchery marking, hatchery returns, in-river harvest
Battle Creek	Fall-run Chinook Salmon	Spawning escapement, hatchery marking, hatchery returns
	Late Fall-run Chinook Salmon	Spawning escapement, hatchery marking, hatchery returns
	Winter-run Chinook Salmon	Hatchery marking, hatchery returns
Butte Creek	Fall-run Chinook Salmon	Spawning escapement

**TABLE 1**  
**CAMP: Recommended Adult Fish Monitoring Programs**

Watershed	Species/Race	Adult Fish Monitoring Programs
<i>Green Sturgeon</i>		
Sacramento-San Joaquin Delta	Green Sturgeon	Estimate based on ratio of Green to White Sturgeon observed during tagging

<sup>1</sup> Data not collected prior to 1998.

<sup>2</sup> Data not collected prior to 1998 and not specifically recommended in CAMP Implementation Plan.

<sup>3</sup> Data collected in 1996 but not in 1997 and not specifically recommended in Implementation Plan.

<sup>4</sup> The juvenile abundance index from the midwater trawl survey conducted by CDFG is currently the best estimator of resulting adult American shad abundance.

**TABLE 2**  
**CAMP: Recommended Juvenile Salmon Monitoring Programs**

Recommended Watershed	Recommended Chinook Salmon Race	Watersheds/Years Included in this Report
American River	Fall-run	1996, 1997, 1998
Battle Creek	Fall, winter, and spring --run	
Butte Creek	Fall and spring-run	
Clear Creek	Fall-run	
Deer Creek	Fall and spring-run	
Feather River	Fall-run	1996, 1998
Merced River	Fall-run	
Mill Creek	Fall and spring-run	
Mokelumne River	Fall-run	1995, 1996, 1997, 1998
Stanislaus River	Fall-run	1996, 1997, 1998
Tuolumne River	Fall-run	
Upper Sacramento River	Fall, spring, and winter-run	
Yuba River	Fall-run	

## Implementation of CAMP through 1998

Not all of the recommended CAMP programs were implemented by the end of 1998 (see Tables 1 and 2). This annual report presents the results of those monitoring programs conducted in 1998 that were consistent with the CAMP Implementation Plan protocols (USFWS 1997). The 1998 data are presented for all target CAMP species; data from the 1995-1997 annual report are presented for comparative purposes.



## 2. Adult Fish Monitoring Program: 1998

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### AFRP Production Targets

The AFRP established watershed-specific restoration targets for chinook salmon and system-wide targets for all five species of anadromous fish monitored by CAMP. Not all streams for which restoration goals were established for fall-run chinook salmon are included in the CAMP monitoring program. The selected watersheds represent 97 percent of the total fall-run chinook production (CAMP Implementation Plan). Therefore, the CAMP production target for fall-run chinook is slightly lower than the overall AFRP target.

### Adult Abundance Estimates: 1998

#### Chinook Salmon

##### *Estimates of Natural Production*

Estimates of the abundance of naturally produced adult chinook salmon in each watershed for monitoring year 1998 are presented in Table 3. These estimates were based on the same assumptions used by the AFRP to establish the 1967 through 1991 baseline estimates (USFWS 1995) and follow the methods outlined in the CAMP Implementation Plan (USFWS 1997). As in previous years, the estimates of total production were calculated by summing in-river estimates (e.g., carcass survey estimates or ladder counts), hatchery returns, and in-river harvest and ocean harvest estimates. Total production was then multiplied by the proportion of natural production in each watershed (estimated by CDFG [1994]) to yield the watershed race-specific natural production estimates. In the future, estimates of natural production should be calculated from actual annual estimates of the proportion of hatchery fish based on the chinook salmon constant fractional marking program at Central Valley hatcheries.

The 1998 production estimates assume that all spring-run and winter-run chinook salmon were naturally produced. Because late fall-run chinook salmon are not distinguished from fall-run fish in the in-river counts, no attempt to estimate the number of naturally produced late fall-run chinook salmon was made. For the purpose of this report, it is assumed that all naturally produced late fall-run fish are included in the fall-run chinook salmon totals. Hatchery return fish identified as late fall-run are presented in this report, but they do not contribute to the natural production totals.

estimates minus Clear and Battle Creek fish. For this report, we have accepted the Red Bluff CDFG estimate of total 1998 fall-run harvest upstream of RBDD as being 8 percent of the 1998 RBDD ladder count (8% is the 1991-1994 average percentage). Previous Sacramento River in-river harvest estimates (USFWS 1998) were estimates based on historical in-river harvests scaled to the annual run size (K. Murphy, CDFG, pers. comm.) (see Table 8).

The watershed-specific component of the ocean harvest of fall-run chinook salmon was calculated by multiplying the total ocean harvest by the watershed-specific proportion of the total in-river run size. The ocean harvest of late fall-run, spring-run, and winter-run fish was assumed to be equivalent to the proportion of the total returning population of chinook salmon that those races represented that year. As described above, the ocean harvest totals were added to other components of adult production to yield total production by watershed and race.

### ***Sacramento River (Mainstem) Fall-run Chinook Salmon Production Estimates***

Estimates of adult chinook salmon production for the mainstem Sacramento River were calculated using the same methods employed by CDFG. The number of adult fish spawning in the mainstem upstream of the RBDD was calculated by subtracting tributary escapement estimates (based on carcass surveys for Clear and Battle creeks), Battle Creek hatchery returns, and estimated in-river harvest from the expanded ladder count (representing the total number of fish passing the RBDD). The resulting estimate of fish spawning in mainstem upstream of RBDD was then used to calculate an estimate of the number of fish spawning in the mainstem downstream of the RBDD by multiplying the above-RBDD spawning estimate by the ratio of redds observed by aerial redd survey below versus above RBDD to yield the below-RBDD estimate. To calculate the CAMP estimate of total production, the in-river harvest and ocean harvest estimates were added to both mainstem spawning escapement estimates to produce an estimate of total mainstem production for the year. The estimate of total production was multiplied by the expected percentage of natural fish (based on AFRP assumptions) to produce an estimate of the total natural production for the year.

This method deviates from the previous method employed by CAMP, and resulted in changes to the estimates of chinook salmon production in the mainstem Sacramento River for 1995 through 1997. The revised estimates are presented in this report. Although the CDFG method was used to maintain consistency, use of this method presents several potential complications. The estimate of the number of fish passing RBDD and the summation of upstream escapement, hatchery returns, and in-river harvest represent independent estimates of the same fish. Deriving an estimate of mainstem spawning escapement upstream of the RBDD by subtracting the estimates of upstream escapement, hatchery returns, and in-river harvest from the ladder count could, in some years, result in an escapement estimate that is negative because of the uncertainty associated with the various estimates. For example, the estimated number of fish returning to the mainstem Sacramento River above the RBDD in 1998 (calculated by subtracting the upstream escapement to Battle and Clear creeks and the hatchery return from the RBDD ladder count) was less than the in-river harvest estimate (based on the 1998 angler surveys), resulting in an estimate of spawning escapement that is a negative number. For 1998, an estimate of in-river harvest using 8 percent of the total number of fish passing RBDD was applied in order to arrive at a positive number of fish. *The discrepancy between the CDFG escapement estimate*

indicator races or species into three categories: (1) those that are at or above their production target, (2) those that are meeting their rebuilding schedule, and (3) those that are not rebuilding. The classification of races or species into these categories is accomplished using recent population data compared to the baseline production data for each race or species and the production target. Races or species that are classified as "above goal" are those for which at least four of the last five years of production estimates are at or above goal and for which the most recent five-year average production is equal to or greater than the goal. Beginning with next year's 1999 CAMP annual report (the fifth year of monitoring), this rebuilding assessment will be used to begin classifying target races and species, and monitor progress toward AFRP goals.

The following presents the estimates of natural production for 1995 through 1998 for each target race and species. Although the number of years of monitoring is not sufficient to perform the assessment described above, the tabulated estimates of natural production presented below provide a qualitative indication of changes in production over the past four years.

### **Fall-Run Chinook Salmon**

In 1998, the estimate of total natural production of fall-run chinook salmon in streams included in the CAMP (324,858) was lower than in any previous year monitored (1995 – 1997) and substantially lower than the CAMP production target (737,600) (Table 5). Watershed-specific natural production targets were exceeded only in Battle Creek, Butte Creek, and the Mokelumne River in 1998. The 1998 natural production estimates for the American, Clear, Deer, Merced, Mill, Mokelumne, Sacramento, and Yuba watersheds were lower than the estimates for 1995, 1996, and 1997. Watershed specific estimates of production for 1995 through 1998 are presented graphically in Figure 1.

The annual in-river escapement estimates (e.g., carcass surveys) and hatchery return data used as input to calculate natural production of fall-run chinook salmon during 1995-1998 generally reflected annual variation within a reasonable range (Tables 6 and 7). The 1998 estimate of in-river escapement was substantially lower than in previous years (Table 6) due, in part, to a reduced number of fish passing over the RBDD and high numbers of fish returning to the hatchery on Battle Creek. Also, the 1998 estimates of in-river harvest (Table 8) showed a substantial deviation (up to five-fold increase) from previous years, particularly for the American and Feather rivers. These increases in the in-river harvest estimates likely reflect the implementation of angler surveys in 1998 – the first angler surveys conducted since the initiation of CAMP monitoring. CAMP's previous in-river harvest estimates for 1995-1997 were based on the proportion of harvest estimated from angler surveys conducted in 1991-1994. In-river harvest during 1991-1994 may have been lower because of reduced fish abundance and angler effort as a result of drought conditions, and application of these estimates to subsequent years may have resulted in an underestimation of in-river harvest. Therefore, the increased in-river harvest in 1998 is likely the result of the combination of both increased angler pressure and harvest in 1998 and a possible underestimation of in-river harvest in previous years.

**TABLE 6**  
**Fall-Run Chinook Salmon In-River Escapement Estimates**

<b>Watershed</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>
American River	70,096	65,915	56,000	43,000
Battle Creek	56,515	52,404	50,743	53,957
Butte Creek	445	500	800	2,500 <sup>a</sup>
Clear Creek	9,298	5,922	8,569	4,258
Deer Creek	564	538	1,203	270
Feather River	59,893	46,301	38,193	43,000
Merced River	1,958	4,599	2,342	2,314
Mill Creek	1,515	1,445	580	546
Mokelumne River	5,417	7,775	10,163	6,952
Sacramento River	39,665	40,870	125,218	5,865
Stanislaus River	611	168	1,642	2,089
Tuolumne River	743	3,602	6,096	7,634
Yuba River	14,561	27,520	25,778	30,802
<b>Total</b>	<b>261,281</b>	<b>257,559</b>	<b>327,327</b>	<b>203,187</b>

<sup>a</sup> Estimate based on professional judgement of biologist working on Butte Creek during adult fall-run chinook salmon migration/spawning in 1998.

**TABLE 7**  
**Fall-Run Chinook Salmon Hatchery Returns**

<b>Watershed</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>
American River	6,498	7,838	6,142	10,581
Battle Creek	26,677	21,178	50,670	44,350
Feather River	11,719	8,710	15,066	18,699
Merced River	602	1,141	946	799
Mokelumne River	3,323	3,883	6,494	3,251
<b>Total</b>	<b>48,819</b>	<b>42,750</b>	<b>79,318</b>	<b>77,680</b>

TABLE 10

Spring-Run Chinook Salmon Baseline Production Estimates, Production Targets and Estimates of Natural Production for 1995 Through 1998

Watershed	Baseline Production Estimate	AFRP Production Targets	Estimate of Natural Production			
			1995	1996 <sup>a</sup>	1997 <sup>a</sup>	1998
Butte Creek	1,000	2,000	5,281	1,546	3,636	38,200
Deer Creek	3,300	6,500	5,301	1,495	1,210	3,553
Mill Creek	2,200	4,400	1,770	680	519	802
Sacramento River	29,000	59,000	1,486	794	491	1,897
<b>Total</b>	<b>35,500</b>	<b>71,900</b>	<b>13,838</b>	<b>4,515</b>	<b>5,856</b>	<b>44,452</b>

### Total Chinook Salmon Production Relative to Other West Coast Watersheds

Figure 2 compares the Central Valley natural production of chinook salmon and natural production of chinook salmon in the Klamath River, Columbia River, and Puget Sound. The in-river run size is based on total escapement plus in-river harvest minus hatchery returns as reported in the *Review of 1998 Ocean Salmon Fisheries* (PFMC 1999). For the purpose of consistency, the numbers for the Central Valley in-river escapement contained in the PFMC report were used even though they differ slightly from the CAMP estimates. Also, the estimates depicted in the figure do not include ocean harvest. In-river run size in the Central Valley over the past four years has been variable, and follows a pattern generally consistent with the Columbia River. Although no trends can be reliably discerned at this time, continued tracking of the Central Valley chinook salmon production relative to other large west coast watersheds may provide insight into the overall effectiveness of restoration efforts.

### Other Species

The AFRP also established natural production targets for steelhead, striped bass, American shad, white sturgeon, and green sturgeon. In 1998, production estimates were available only for American shad. The available natural production estimates for these species for 1995, 1996, 1997, and 1998 are presented in Table 11.

TABLE 11

Steelhead, American Shad, Striped Bass, White Sturgeon, and Green Sturgeon Adult Spawner Estimates for 1995 Through 1998

Species	AFRP Restoration Target	Adult Spawner Abundance Estimate			
		1995	1996	1997	1998
Steelhead	13,000	NA	NA	NA	NA
American Shad	4,300	6,859	4,312	2,302	4,142
Striped Bass	2,500,000	NA	775,000	NA	NA
White Sturgeon	11,000	NA	NA	106,000	NA
Green Sturgeon	2,000	NA	NA	1,452 <sup>a</sup>	NA

<sup>a</sup> 1.37% of white sturgeon total

### 3. Juvenile Monitoring Program: 1998

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The CAMP juvenile monitoring program was established to assess the relative effectiveness of categories of CVPIA restoration actions (water management modifications, structural modifications, habitat restoration, and fish screens) toward meeting the AFRP anadromous fish production targets. In this chapter, the effects of each of these action categories on juvenile chinook salmon abundance are evaluated for the following streams:

- American River
- Feather River
- Mokelumne River
- Stanislaus River

The target species/race for analysis in these streams was fall-run chinook salmon. Table 12 summarizes the restoration actions implemented in recent years on these streams. Appendix A discusses restoration actions in detail. Estimated numbers of juvenile chinook emigrating from each stream in 1998 are summarized in Table 13. Detailed analysis of juvenile abundance in each stream is provided in Appendix B.

The watersheds monitored to date are not markedly different in terms of completed restoration actions (Table 12). Water management modifications have been made in recent years in all four streams. Habitat restoration projects were completed at several sites in the Mokelumne, Stanislaus, and American rivers. One structural modification, reconfiguration of the shutters at Folsom Dam, was completed on the American River. No fish screening projects have been completed in these streams.

It is probable that the restoration actions completed to date have increased the success of chinook salmon spawning and rearing in these streams and have resulted in higher abundance of juveniles emigrating each winter and spring compared to previous years. The most recent years show the highest values of the index of juvenile to adult spawners over the four years of record (Table 14). Natural environmental variation, such as extreme high flows in early 1997, reduce our ability to discern differences due to action types given the limited juvenile abundance data. In all cases, pre-project monitoring was either not available or not conducted with comparable methods to the CAMP program. In addition, in some streams and years, sampling was not conducted over the entire fall-run emigration period.

In future years, comparisons of abundance over time in each stream will be improved. Also, as more watersheds are included in the program, there will be an overall wider variety of restoration actions implemented for comparison and evaluation. The current summary of juvenile data does not lend itself to statistical interpretation. However, estimates of indices of juveniles per adult spawner shown in Table 14 suggest general improvement over time among watersheds that could be attributed to the restoration actions shown in Table 12.

While the CAMP juvenile program is intended to provide long-term watershed-specific monitoring of juvenile production, these data are not sufficient to distinguish the relative effectiveness of the four categories of actions to restore anadromous fish populations. Data

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## **Appendix A**

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### **CAMP Juvenile Monitoring Program: Effects of Restoration Actions on Abundance of Juvenile Chinook Salmon at Emigration**



# Contents

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Section	Page
Water Management Modifications .....	A-1
American River.....	A-1
Feather River.....	A-2
Mokelumne River.....	A-2
Stanislaus River .....	A-2
Habitat Restoration.....	A-3
Mokelumne River.....	A-3
Stanislaus and American Rivers .....	A-3
Structural Modifications.....	A-4
American River.....	A-4
Fish Screens .....	A-4

## APPENDIX A

# CAMP Juvenile Monitoring Program: Effects of Restoration Actions on Abundance of Juvenile Chinook Salmon at Emigration

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This Appendix provides the detailed methods and results summarized in Section 3 of the 1998 CAMP Annual Report. The Appendix includes a documentation of the AFRP Actions implemented in each of the watersheds for which juvenile salmon emigration data was available. The Actions are grouped into the categories of:

- Water Management Modifications
- Habitat Restoration
- Structural Modifications
- Fish Screens

Restoration actions in three of the four action categories have been implemented for the watersheds for which juvenile salmon monitoring data are included in this report. Data for only limited number of restoration actions precludes definitive conclusions regarding the effectiveness of action categories for this first report. In the future, as more watersheds with restoration actions in the four categories are monitored over a greater number of years it is likely that links between juvenile success and restoration actions will become apparent.

## Water Management Modifications

CVPIA-related and other water management modifications have been made in recent years in each of the streams included in the juvenile monitoring analysis in this report (American, Feather, Mokelumne, and Stanislaus rivers).

### American River

On the lower American River, flow releases from Folsom Dam have been modified in recent years to reflect target release levels by the Sacramento Area Water Plan Forum based on inflow and storage levels at Folsom Reservoir. The AFRP program has adopted these release schedules into annual flow recommendations for the use of dedicated water on the lower American River.

Since 1994, higher flow releases have been made in the fall months to benefit salmonid spawning and egg incubation. Higher fall flows have been shown to result in increased spawning and incubation success. The majority of fall-run chinook emigrate from the lower American River as fry soon after emerging from the gravel, making the spawning and egg incubation stages the most critical.

The flow schedule varies releases in the fall, winter, and early spring on the lower American River between years depending on hydrologic conditions. This variation makes evaluation

Evaluation of the effects of flow changes in recent years is difficult, because flow allocations for fishery purposes vary between years based on variations in hydrology, and releases are made to the lower river to meet many other needs. Flow augmentations in the spring of 1995 and 1996 probably increased survival of outmigrating juvenile chinook, but because outmigrant data for the Stanislaus River have only been collected using standardized techniques beginning in 1996, it is not possible to directly evaluate the effectiveness of water management modifications in increasing juvenile production.

## **Habitat Restoration**

Habitat restoration projects were implemented on three of the streams included in the analysis, the Mokelumne, Stanislaus, and American rivers.

### **Mokelumne River**

On the Mokelumne River, several salmon spawning gravel restoration projects have been implemented by EBMUD in recent years. In 1992, EBMUD placed approximately 300 cubic yards of salmon spawning gravel in the Mokelumne River in the vicinity of Murphy Creek. The project was continued over subsequent years in cooperation with CDFG and the California Department of Parks and Recreation Habitat Conservation Fund Program. Projects have typically consisted of placing clean river gravel (1 - 4 inch diameter) in known spawning areas.

In the fall of 1993, 500 cubic yards of gravel were placed at the Mokelumne River Day Use Area (MRDUA). The following year, the substrate was ripped and another 100 cubic yards of gravel were placed at the MRDUA. In the fall of 1996, EBMUD placed over 650 cubic yards of clean river gravel at three sites, two at the MRDUA and one near Mackville Road. In 1997, 1,500 cubic yards of gravel (1 - 8 inch diameter) were placed at three sites (one at the MRDUA, one near Mackville Road, and one site about one mile below Mackville Road).

Spawning gravel restoration projects in recent years probably have increased the success of chinook salmon spawning, egg incubation, and early rearing in project areas. However, comparable juvenile outmigrant data is not available at the watershed scale for years prior to project implementation, making pre- and post-project comparisons difficult. Biological staff at EBMUD have been conducting site-specific monitoring at each of the gravel projects completed thus far. The number of salmon spawning redds in each restored riffle area have been monitored pre- and post-project, and compared as a proportion of the total number of spawning redds in the lower river each year. Substrate size, intergravel permeability, dissolved oxygen, temperature, and macroinvertebrate production also have been measured at project sites pre- and post-restoration. Results of these studies are in draft form and were not available for inclusion in this report.

### **Stanislaus and American Rivers**

On the lower Stanislaus River, two gravel restoration projects have been implemented in recent years. In 1994, three spawning riffles at River Mile (RM) 47.4, 50.4, and 50.9 near Horseshoe Park were reconstructed, funded by the 4-Pumps Agreement. In 1995, these sites were revegetated using vegetation stock from the site. In 1997, 1,000 tons of salmon spawning gravel were added at each of two sites in Goodwin Canyon below Goodwin Dam.

As more watersheds are brought into the CAMP juvenile salmon monitoring program, both pre-and post-screen conditions will be assessed. CAMP is currently reviewing existing and planned fish screen facilities to select representative locations for conducting focused evaluations of the effectiveness of fish screens in meeting AFRP goals. A pilot program to evaluate fish screen effectiveness is expected to be initiated in 2000.

## **Appendix B**

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**CAMP Juvenile Monitoring Program:  
Summary of Juvenile Chinook  
Salmon Monitoring, 1995-1997  
Detailed Methods and Results**

# Contents

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Section	Page
Introduction.....	B-3
American River.....	B-5
Methods.....	B-5
Results.....	B-6
Feather River.....	B-8
Methods.....	B-8
Results.....	B-9
Mokelumne River.....	B-11
Methods.....	B-11
Results.....	B-12
Stanislaus River.....	B-13
Methods.....	B-13
Results.....	B-14
References.....	B-17

## Tables

B-1	Rotary Screw Trap Programs Included in the Current CAMP Juvenile Monitoring Program Report.....	B-4
B-2	Estimated Number of Fry (< 50 mm) and Juveniles (50mm to 125 mm) Emigrating from the Lower American River, 1996-1998. ....	B-6
B-3	Estimated Number of Fry (< 50 mm) and Juveniles (50mm to 125 mm) Emigrating from the Feather River in 1996 and 1998.....	B-10
B-4	Estimated Number of Fry (< 50 mm) and Juveniles (50mm to 125 mm) Emigrating from the Mokelumne River, 1995-1998. ....	B-12
B-5	Estimated Number of Fry (< 50 mm) and Juveniles (50mm to 125 mm) Emigrating from the Lower Stanislaus River, 1996-1998. ....	B-15

## Figures

- B-1** Estimated Number of YOY Chinook Salmon Emigrating from the Lower American River Each Day During 1998..... B-6
- B-2** Mean Daily Flow (cfs) at Fair Oaks, October 1997 Through June 1998 and Estimated Abundance of YOY Chinook Salmon Emigrating from the Lower American River During 1998..... B-7
- B-3** Mean Daily Water Temperature (°F) at Watt Avenue or Nimbus Dam on the Lower American River, October 1997 - June 1998..... B-8
- B-4** Estimated Number of YOY Chinook Salmon Emigrating from the Feather River Each Day During 1998..... B-9
- B-5** Mean Daily Flow (cfs) at Gridley, October 1997 Through June 1998 and Estimated Abundance of YOY Chinook Salmon Emigrating from the Feather River During 1998..... B-10
- B-6** Estimated Number of YOY Chinook Salmon Emigrating from the Mokelumne River Each Day During 1998..... B-12
- B-7** Mean Daily Flow (cfs) at Camanche Dam, October 1997 Through June 1998 and Estimated Abundance of YOY Chinook Salmon Emigrating from the Mokelumne River During 1998..... B-13
- B-8** Estimated number Number of YOY chinook Chinook salmon Salmon Emigrating from the Lower Stanislaus River Each Day During 1998..... B-15
- B-9** Mean Daily Fow (cfs) at Goodwin Dam, October 1997 Through June 1998 and Estimated Abundance of YOY Chinook Salmon Emigrating from the Stanislaus River During 1998..... B-16
- B-10** Mean Daily Water Temperature (°F) at Goodwin Dam on the Lower Stanislaus River, October 1997 - June 1998 (USGS)..... B-17

# **CAMP Juvenile Monitoring Program: Summary of Juvenile Chinook Salmon Monitoring, 1998.**

## **Detailed Methods and Results**

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### **Introduction**

Target streams were selected based on the presence of target races, opportunities to spatially isolate the effects of actions, the implementation schedule for restoration actions, and the presence of existing juvenile and adult monitoring programs. Target streams for juvenile monitoring include the American River, Battle Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Merced River, Mill Creek, Mokelumne River, Sacramento River (upper mainstem), Stanislaus River, Tuolumne River, and the Yuba River.

To monitor the entire period of juvenile outmigration for each target race, the following sampling periods were selected. In streams with fall-run chinook salmon only, as were sampled in 1998, sampling will be conducted from January 1 - June 30.

Rotary screw traps were selected as the standard gear to sample juvenile chinook salmon abundance in the CAMP program. Although rotary screw traps have been used in some Central Valley streams since 1991 to monitor juvenile salmon, sampling programs have often been under-funded, sporadic, or short-term. Implementation of the CAMP juvenile program in 1998 provided funding for new rotary screw trap programs and established a consistent, long-term data management and retrieval system.

A standardized protocol for rotary screw trap sampling was developed for the CAMP based on the protocols used in existing studies on the upper Sacramento River at Red Bluff (by the USFWS), the upper Sacramento River at Balls Ferry (by the CDFG), the lower Sacramento River at Knights Landing (by the CDFG), the lower American River (by the CDFG), and the lower Stanislaus River (by S.P. Cramer and Associates under contract to the USFWS).

This report provides results of rotary screw trap sampling for fall-run chinook salmon during 1998 in four streams where programs have existed since 1995. These programs used methods that conformed, with some exceptions, to the standardized protocol developed for CAMP. The streams and sampling locations are included in Table B-1.



## American River

### Methods

Rotary screw traps have been used by the CDFG Stream Flow and Habitat Evaluation Program, beginning in 1992, to monitor juvenile emigration from the lower American River. The first full sampling season was in 1994. From 1992 to 1995, the study was funded by EBMUD. Since 1995, funding has been provided by the USFWS or the USBR pursuant to the CVPIA.

Methods used for rotary screw trap sampling on the lower American River were incorporated in development of the CAMP standard protocol. Therefore, sampling methods on the lower American River were generally consistent with the CAMP standard protocol.

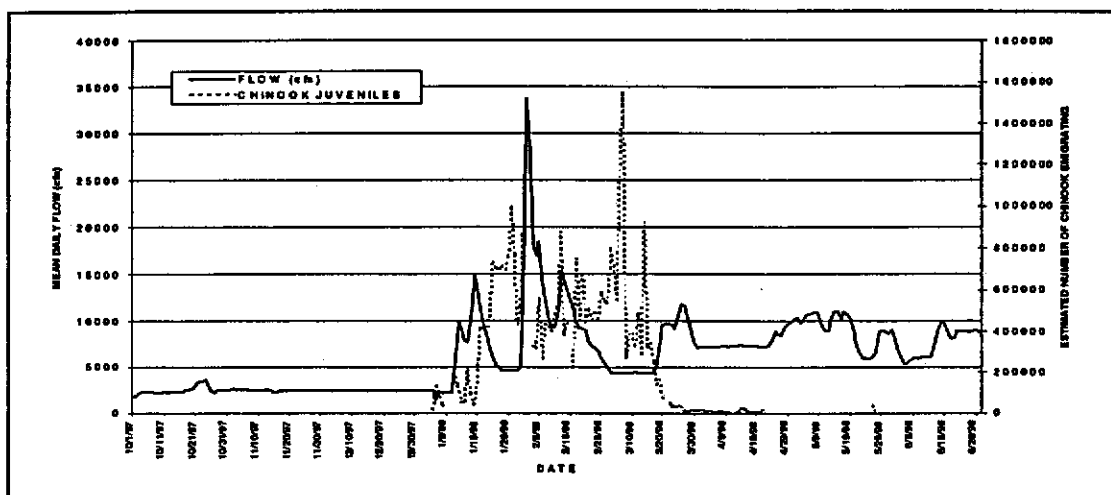
In 1996, 1997, and 1998, a single rotary screw trap (8 foot diameter) was fished just downstream of the Watt Avenue bridge in Sacramento (RM 9). Sampling was conducted continuously from October 1995 through September 1996, from mid-December 1996 through June 1997, and from mid-November through July 1998. Results from the standard period of fall-run chinook emigration, January 1 - June 30, 1998 are included in this report.

Traps were fished 24 hrs/day, 7 days/week, and checked once or twice daily. During each trap check, fish were removed from the trap, sorted, and counted by species. From 50 to 100 individuals of each species were subsampled from the start, middle, and end of each catch, for a total of 150 to 300 fish per trap catch. Subsampled fish were measured and weighed (fork length to the nearest 0.5 mm, and weight to the nearest 0.1 g). Measured salmonids were visually classified as yolk-sac fry, fry, parr, silvery parr, or smolts. Water transparency (secchi disk depth), water temperature, and effort (hours fished since last trap check) were recorded during each trap check (CDFG 1997). Flow data used in this report were obtained from USGS gage 11446500 at Fair Oaks, California.

Trap efficiency tests were conducted on a weekly basis from January 21 through May 6 in 1996, from January 21 through March 24 in 1997, but were not reported for 1998. Fish captured in the trap were marked and released approximately 2,500 feet upstream. In 1996, fish were marked using Alcian blue dye; a specific pattern was used to indicate the week of marking. In 1997, fish were marked using a Bismark brown bath. Use of this dye enabled much larger release groups to be marked. During each efficiency test, all fish measured were also checked for marks. When all fish were not checked, the number of recovered fish was expanded by the proportion of fish checked to the total number captured. When no fish were recaptured in a test, results of the test were not used. Calculated efficiency rates (number of recaptures/number of marked fish in release group) varied from 0.00101 to 0.01217 in 1996, and 0.00424 to 0.02399 in 1997. An average value for trap efficiency from 1996 through 1997 (0.00595) was used in 1998, due to the unavailability of 1998 trap efficiency data. The average trap efficiency was applied to raw catch data on each date to estimate the number of juvenile chinook salmon emigrating on that day, by size class (estimated number = raw catch / trap efficiency)

### ***Relationship of juvenile abundance to environmental factors: Effect of streamflow on survival and timing of juvenile outmigration***

Figure B-2 shows the mean daily flow (cfs) at the gage site during the egg incubation, juvenile rearing and emigration period in 1997 – 1998 (October 1997 through June 1998) and the abundance of YOY chinook salmon emigrating from the lower American River.



**Figure B-2. Mean Daily Flow (cfs) at Fair Oaks, October 1997 Through June 1998 and Estimated Abundance of YOY Chinook Salmon Emigrating from the Lower American River During 1998.**

Flows were relatively low and constant at about 2,500 cfs from the beginning of October 1997 to the middle of January 1998. These flows were not high enough to stimulate early emigration of emerging fry. From mid-January through February, 1998, flows were high and variable, peaking of over 30,000 cfs. These high flows coincided with the period of high fry outmigration during January and February. Flows during March and April were relatively constant, averaging around 7,000 cfs. Fry continued to emigrate in high numbers throughout March. Relatively low numbers of chinook salmon emigrated in April. Flows were more variable in May and June (5,000 to 11,000 cfs.).

Although the period of high fry outmigration in 1998 coincided with a period of relatively high flows in January and February, it is unclear whether the high flows stimulated outmigration. Outmigration occurred at a higher rate and earlier in 1998 than in either 1996 or 1997.

#### **Effect of Water Temperature on Juvenile Abundance**

Water temperatures were measured by CDFG at Nimbus Dam in 1997-1998. A Stowaway recorder was used to measure water temperature at Nimbus Dam. Mean daily water temperatures from October 1997 through June 1998 are shown in Figure B-3.

Temperatures declined steadily during the fall in 1998 from near 67° F in October to around 50° F in December. Temperatures in November and December 1997 were similar to temperatures recorded during the same period in 1996. It is probable that the cooler water

A single trap efficiency test was conducted in 1998 at the Live Oak site. Fish captured in the trap were marked by fin clipping (dorsal or caudal fin) and held in live boxes adjacent to the traps. Fish were kept for 1-5 days prior to release approximately 1 km upstream of the trap. The trap efficiency was as 0.002 in 1998. This efficiency was applied to raw catch data for all 1998 dates to estimate the number of juvenile chinook salmon emigrating on that day, by size class (estimated number = raw catch / trap efficiency).

## Results

### *Estimated Abundance*

The estimated daily number of fry and other juvenile YOY chinook salmon emigrating from the Feather River in 1998 are shown in Figure B-4.

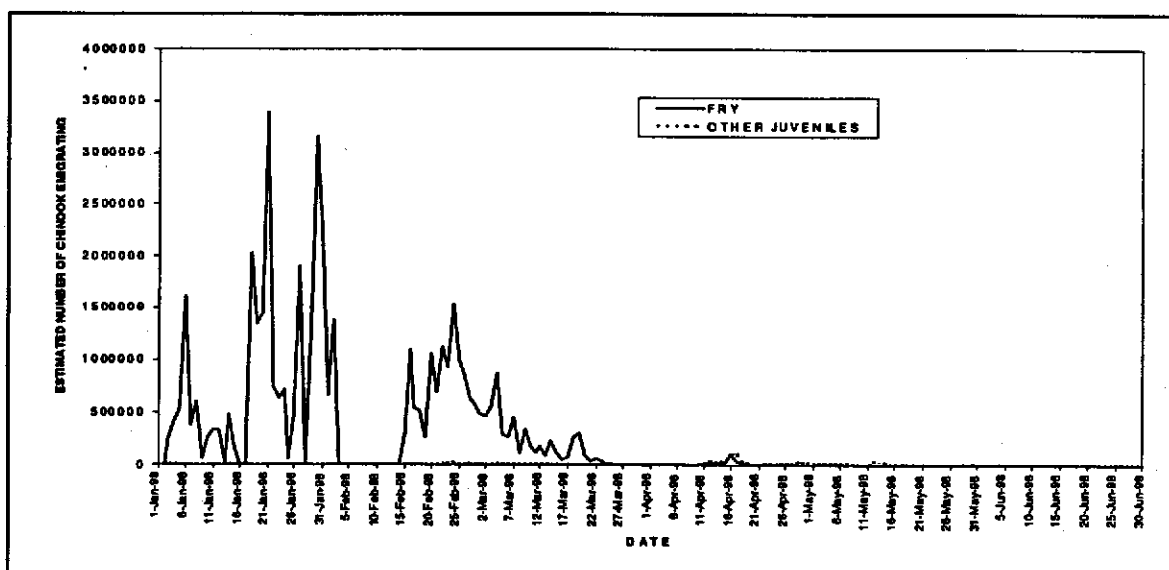


Figure B-4. Estimated Number of YOY Chinook Salmon Emigrating from the Feather River Each Day During 1998.

In 1998, the majority of YOY emigrated from the Feather River as fry. This is consistent with the pattern seen in 1996 (Table B-3). Fry emigration during 1998 peaked in mid- to late-January and was high throughout February, declining in March. A small number of fry were caught after the first week of April. The abundance of larger juveniles peaked in mid-April, with emigration continuing through May.

The extremely high estimate of total juvenile production for the Feather River in 1998 may be an artifact of the application of a single trap efficiency, rather than multiple trap efficiency tests as recommended in the CAMP protocols, to the capture data.

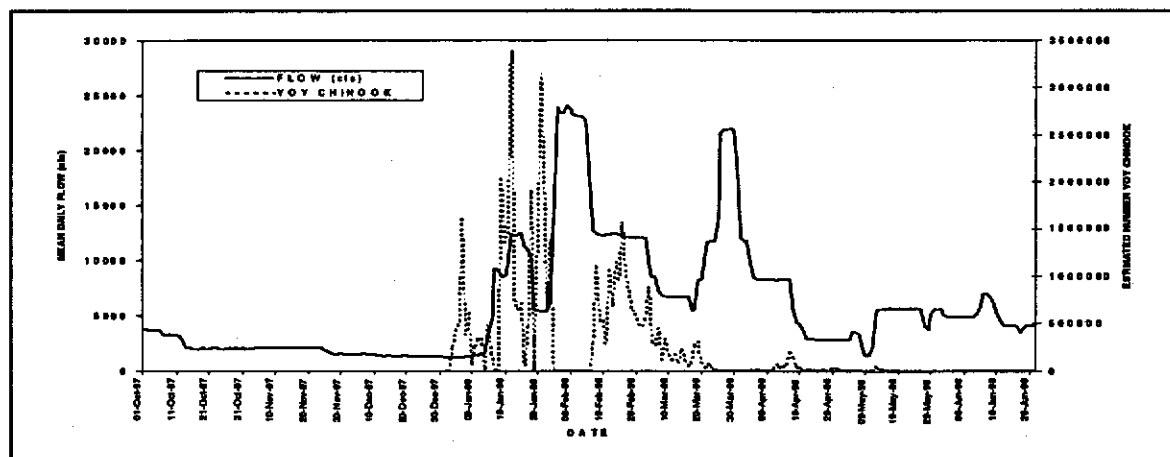
TABLE B-3.

Estimated Number of Fry (&lt; 50 mm) and Juveniles (50mm to 125 mm) Emigrating from the Feather River in 1996 and 1998.

Life Stage	Estimated Number of Outmigrants	
	1996	1998
Fry (less than 50 mm)	550,500	43,908,500
Juvenile (50-125 mm)	90,500	1,188,500
<b>TOTAL</b>	<b>641,000</b>	<b>45,097,000</b>

***Relationship of juvenile abundance to environmental factors: Effect of streamflow on survival and timing of outmigration***

Flow data for the Feather River were obtained from the DWR gage located at Gridley, California. Figure B-5 shows the mean daily flow (cfs) at the gage site during the egg incubation, juvenile rearing and emigration period in 1997 - 1998 (October 1997 through June 1998) and the abundance of YOY chinook salmon emigrating from the Feather River from January through June, 1998.



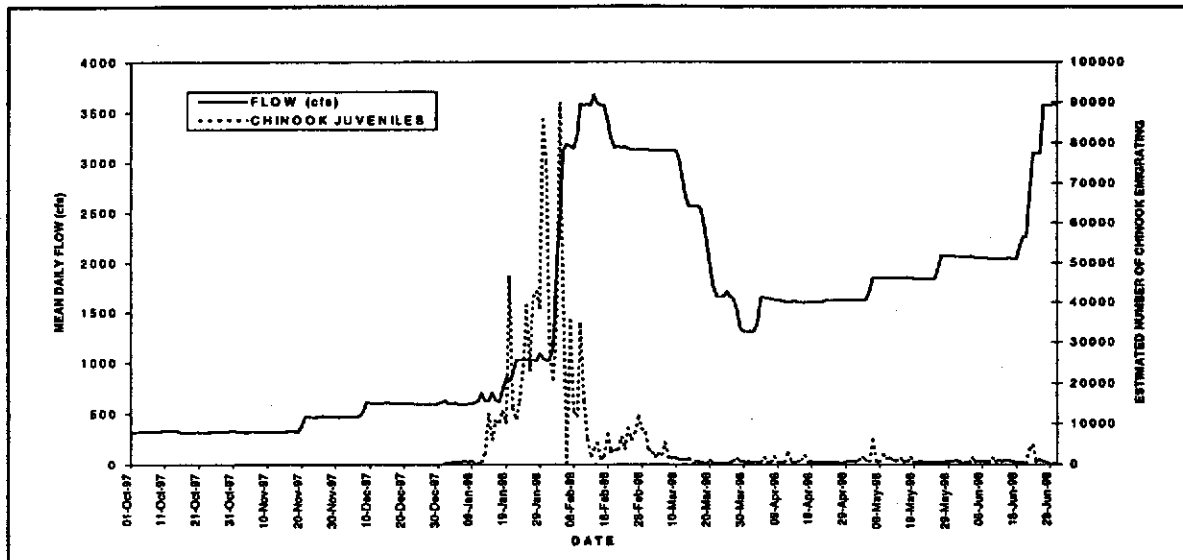
**Figure B-5. Mean Daily Flow (cfs) at Gridley, October 1997 Through June 1998 and Estimated Abundance of YOY Chinook Salmon Emigrating from the Feather River During 1998.**

Flows throughout October, November, and the beginning of December were relatively low. Some fry emigration probably occurred in December, prior to the start of sampling. Flows increased during January and remained high throughout February, with a peak occurring in mid-February forcing trapping to be discontinued for a short time. High flows at the end of March again forced trapping to be discontinued for a short time. Emigration began prior to the period of high flows and peaked before the peak in flow. It is unknown if flows had a significant effect on the timing of emigration.

### *Relationship of juvenile abundance to environmental factors:*

#### **Effect of streamflow on survival and timing of outmigration**

Flow data for the Mokelumne River were obtained from USGS gage 11323500, located below Camanche Dam. Figure B-7 shows the mean daily flow (cfs) at the gage site during the egg incubation, juvenile rearing and emigration period in 1997 - 1998 (October 1997 through June 1998) and the abundance of YOY chinook salmon emigrating from the Mokelumne River from late January through June, 1998.



**Figure B-7. Mean Daily Flow (cfs) at Camanche Dam, October 1997 Through June 1998 and Estimated Abundance of YOY Chinook Salmon Emigrating from the Mokelumne River During 1998.**

Flows from October through November 1997 were relatively low and stable at around 300 cfs. Flows increased in mid to late November to around 500 cfs and again in early December to around 600 cfs. Flows continued to increase during January with a dramatic increase in early February, 1998 to around 3,500 cfs. Flows remained high through early March when they declined to around 1,500 cfs. The timing of emigration did not appear to be strongly related to changes in flow. Peak fry emigration occurred in late-January before the peak in flows. Peak emigration of larger juveniles also occurred during a period of relatively high and stable flows in early May.

## **Stanislaus River**

### **Methods**

Rotary screw traps have been used since 1994 to monitor juvenile emigration on the lower Stanislaus River at Caswell State Park (RM 8.6) (Demko and Cramer 1997). In 1994, CDFG fished one trap and in 1995, USFWS fished two traps at the site. In these years, traps were

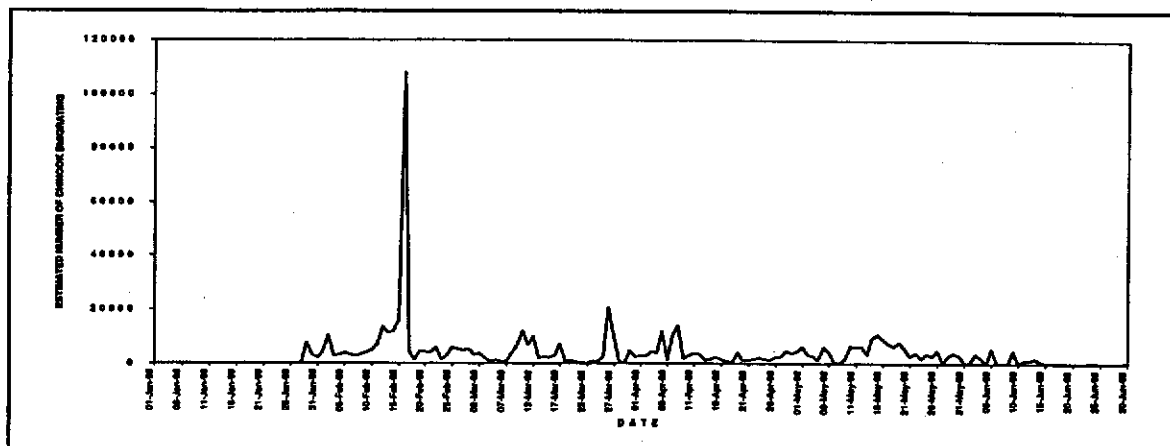


Figure B-8. Estimated number Number of YOY Chinook Salmon Emigrating from the Lower Lower Stanislaus River Each Day During 1998.

Table B-5 presents the estimated number of fall-run chinook salmon emigrating from the lower Stanislaus River from 1996 through 1998. Significant numbers of fry probably emigrated prior to the start of sampling in 1998.

TABLE B-5.

Estimated Number of Fry (< 50 mm) and Juveniles (50mm to 125 mm) Emigrating from the Lower Stanislaus River, 1996 - 1998.

Life Stage	Estimated Number of Outmigrants		
	1996	1997	1998
Fry (less than 50 mm)	41,026	85	N/A
Juvenile (50-125 mm)	64,187	46,835	N/A
<b>TOTAL</b>	<b>105,207</b>	<b>46,920</b>	<b>650,917</b>

***Relationship of juvenile abundance to environmental factors: Effect of streamflow on survival and timing of outmigration***

Flow data for the lower Stanislaus River were obtained from USGS gage 11302000 located at Goodwin Dam near Knight's Ferry, California. Figure B-9 shows the mean daily flow (cfs) at the gage site during the egg incubation, juvenile rearing and emigration period in 1997 - 1998 (October 1997 through June 1998) and the abundance of YOY chinook salmon emigrating from the lower Stanislaus River.

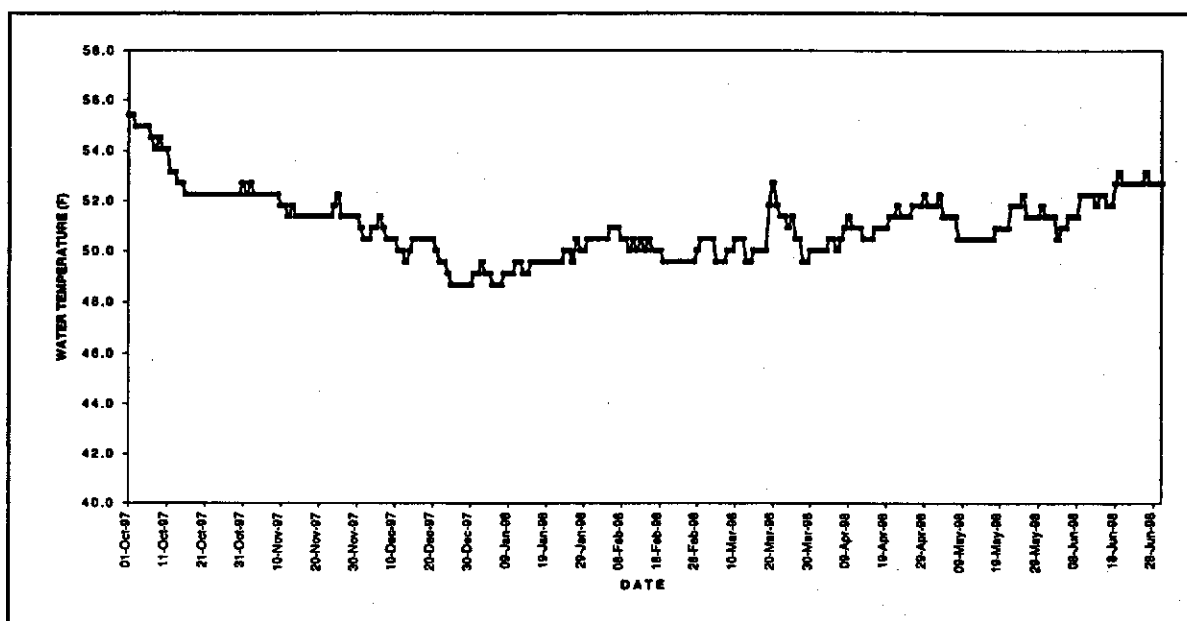


Figure B-10. Mean Daily Water Temperature (°F) at Goodwin Dam on the Lower Stanislaus River, October 1997 - June 1998 (USGS).

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East Bay Municipal Utility District, Department of Fish and Game, and U.S. Fish and Wildlife Service. 1996. Principles of agreement for a joint settlement agreement concerning the flows and non-flow measures appropriate to the lower Mokelumne River in the matter of FERC Lower Mokelumne River Project No. 2916-004 proceeding.